1.0 CONTROL PHILOSOPHY

The Control of boiler operation has been envisaged through DCS (redundancy considered in power supply 24V, communication module and processor). Operator interface has been considered through 2 Nos. 21" colour monitor (1no. as Engineering cum operator station).

1.1 The major control of the boiler and its auxiliaries realised in DCS includes the following:

1. Three element drum level control
2. Combustion control
3. Super heated steam temperature control
4. Furnace draft control
5. Deaerator level control
6. Deaerator pressure control
7. CBD level control
8. Soot blower steam pressure control
9. Auto-sequential operation of soot blowers

1.1.1 Three element drum level control :

Reference document (JB0632/33-50990400-CLS-001; sh 2): Control loop diagram for three-element drum level control

The multivariable three-element control strategy is implemented to regulate drum level control.

The three elements constituted drum level, feed water flow and main steam flow are developed to regulate this boiler via drum level.

A. Level :

Drum level is measured with the help of level transmitters (LT-01 and LT-02). The output of this transmitter is compensated for drum pressure. Drum pressure is measured with the help of drum pressure transmitter (PT-01).

As the characteristics of drum pressure Vs drum level is non- linear. Drum pressure is passed through function generator f (p) (for generation of non- linear curve) the output of which is multiplied with drum level signal to generate compensated level signal.

Two Nos. of generated outputs for drum level HI and LO from drum level controller are used for annunciation circuit as drum level High/Low alarm. Drum level HI HI and drum level LO LO signals are generated from drum level HI HI and LO LO trip switches for the remote water level indicator at boiler operating trip floor and same is connected to LT-01.
In the single element control selection, LIC-01 controller generates output and feed water flow will be regulated by 30% control loop through I/P-02.

B. Main Steam Flow :

Main Steam flow is measured with the help of steam flow transmitter (FT-02). This transmitter output is compensated for main steam pressure (PT-02) and main steam temperature (TT-05).

This compensated flow is computed in flow computing circuit where,

$$Q = K1 * P/T * \sqrt{h}$$

Where, h = differential pressure across the flow element
P = Main Steam Pressure
T = Main steam temperature
K1 = Constant
Q = Compensated flow

This compensated steam flow is used for control and totalisation.

C. Feed Water Flow :

Feed Water Flow is measured with the help of flow transmitter (FT-01). The output of this transmitter is being sent to the DCS for control and totalisation.

D. 3-element Control Loop :

The drum level compensated signal is compared with the set point in the primary level controller (LIC-1) and the output of the control system is added with the feed forward signal of compensated steam flow.

This computed output with bias becomes the remote set point for feed water flow controller (FIC-01) whose process input is feed water flow. The output of this controller shall regulate the 100% control valve (FCV-01) through I/P converter (I/P-01).

1.1.2 Automatic Combustion Control :

The combustion control of the boiler depends on the steam demand from the system. If the steam demand from the system is high, then the Main Steam header pressure (PT-02) is low. In order to maintain a constant pressure, the steam generation shall be increased by increasing combustion airflow and fuel flow. This header pressure is considered as major parameters for combustion control.

The Loop :

The measured value is compared with Main Steam header pressure set point meant for fuel flow and combustion airflow control logic system. The master pressure controller will generate the demand signal for fuel and air (PIC-02 to be realised in DCS).

This final output gives the fuel demand for boiler (common output 06 nos. fuel feeders VFD).

A ratioed signal (from fuel flow control system) is added to the output of air vs load curve and also sent to the airflow controller logic system as a remote set point.

Oxygen trimming controller (AIC-100 to be realised in DCS) is also giving the output to the airflow controller and the same is added with the airflow signal through (FT-200- FD air flow) and send to the airflow controller (FIC-200 to be realised in DCS) as a corrected airflow signal. FD airflow is controlled.

Final output from airflow controller will regulate FD air either through inlet guide vane or through variable speed operation of FD fans.

The following modes of operation are envisaged for FD fans :

a. VFD mode : The inlet guide vane (IGV) is kept in manual mode and the operator shall maintain IGV full open (100%) and the O/P of the controller will regulate speed of FD fan to maintain FD fan air.

b. DOL/Soft Starter mode : In case of operational problem in VFD panel, the FD fan will be run in DOL mode at constant speed and the controller will regulate the IGV operations of individual fan through a power cylinder and I/P converters.

SA fans airflow is controlled through manual dampers in field that are to be kept at certain opening to maintain discharge pressure.

1.1.3 Superheated steam temperature control :

This loop maintains a constant temperature (425°C ± 5°C) at secondary super heater O/L for the control range of 60% - 100% of boiler MCR load.
A cascade control strategy is followed to take care of primary super heater stage outlet (TIC-04) temperature response to the spray water control provided at DSH through control valve TCV-01 & I/P-03 so as to maintain temperature at final steam.

Controller TIC-04 receives input process signal from TT-04 (steam temperature. at attemperator outlet) and master controller (TIC-05) receives process value from TT-05 (main steam temperature. before main steam stop valve) and whose output is remote set point for TIC-04.

1.1.4 Furnace draft control :

This loop keeps the furnace pressure constant as a predetermined value. The furnace pressure is measured by the transmitter PT-100 that is used as feed back signal to the controller (PIC-100).

The output of controller will regulate furnace draft either through inlet guide vane or through variable speed operation of ID fan #1 and ID fan#2.

The following modes of operation are envisaged for ID fans :

a. VFD mode : The inlet guide vane (IGV) is kept in manual mode and the operator shall maintain IGV full open (100%) and the O/P of the controller will regulate speed of ID fan to maintain Furnace draft.

b. DOL/Soft Starter mode : In case of operational problem in VFD panel, the ID fan will be run in DOL mode at constant speed and the controller will regulate the IGV operations of individual fan through a power cylinder and I/P converters.

1.1.5 Deaerator Level Control :

The loop maintains the Deaerator (D/A) level at a predetermined value. The level is sensed by the level transmitter (1LT-51) and used as a feed back signal to the controller (1LIC- 51). This final output of the controller through I/P converter (1I/P-51) will regulate the control valve (1LCV-51).

1.1.6 D/A Pressure Control :

This loop maintains the D/A pressure within a predetermined value. The pressure is sensed by the pressure transmitter (1PT-50) and is used as a feed back signal to the control system (1PIC-50). The output of controller through the I/P converter (1I/P-50) will regulate the steam pressure to D/A through control valve (1PCV-50).

1.1.7 CBD Level control :

The loop maintains the CBD vessel level at a predetermined value. The level is sensed by the level transmitter (LT-26) and used as a feed back signal to the controller (LIC-26) to be realised DCS. This final output of the controller through I/P converter (I/P-26) will regulate the control valve (LCV-26).

1.1.8 Soot blower steam pressure control :

This loop is to maintain the soot blower steam pressure at a predetermined value. Soot blower steam pressure is sensed by PT-05 and is used as a feed back signal to the controller PIC-05. The output of the controller through I/P converter (I/P-05) and control valve (PCV-01) is to control soot blower steam pressure.

1.1.9 Auto-sequential operation of retractable (02nos.) and rotary soot blowers (14nos.)

Operation of the Soot Blower

GENERAL :

Three modes of operations are possible in the DCS

1. Auto sequence mode.
2. Semi sequence mode.
3. All by pass.

AUTO SEQUENCE MODE :

In this mode all the soot blower are kept in sequence mode. Soot blower starts working serially in sequence as soon as Auto ON Push Button (AOPB) is pressed in DCS. After operating last soot blower cycle, end relays operates and Auto cycle stops.

SEMI SEQUENCE MODE :

In this mode, blowers that are not required to operate are kept in bypass mode & the other are kept in sequence mode.

Blowers that are kept in sequence mode starts working serially in sequence when auto start button (AOPB) is pressed. Cycle end, at the operation of last blower, which serially last in the sequence. AOPB is to be realised in DCS

For example, if blower No. 1,3 is in sequence mode and 2 is in by pass mode, blower No. 1 will operate first, then blower 3 & after completing operation of blower 3, auto sequence operation OVER signal will come, Blower no 2 will not operate.

BY PASS MODE :

In this mode Auto/Bypass sequence switches of all the blowers are kept in bypass mode. No soot blower will operate in this mode from DCS.

OPERATING SEQUENCE (ALL SOOT BLOWERS IN SEQUENCE MODE) :

Auto sequence contact will hold when auto ON push button (AOPB) is pressed & following conditions are full filled.

a. Auto manual switch (AMSW) in auto (AMSW to be realised in DCS)
b. Auto sequence operation over contact de-energises (To be developed in DCS).
c. Auto ON pressed from operator station
d. All soot blowers are in remote mode (From MCC).
e. All soot blowers are in home position.

Before starting the soot blowing, operator has to check the required temperature of steam in the steam blowing line by keeping inlet & drain valve open for some time
and during blowing, drain valve shall be kept in close condition.
After soot blowing complete, first inlet isolation valve shall be closed and after some time drain valve shall be closed.

2.0 INTERLOCK AND PROTECTION SYSTEM:

2.1.1 F**or 90 TPH boiler:** Interlock and protection of boiler has been envisaged through DCS system to take care of the safe start up / stopping / tripping sequence of the following drives :

a. FD fan	:	02nos.
b. SA fan	:	02nos.
c. ID fan	:	02nos.
d. PA fan	:	02nos.
e. Bagasse drum Feeders	:	06nos.
f. Fuel screw Feeders	:	06nos.
g. Boiler feed pumps	:	06nos
h. Turbo Feed Pump	:	01no.
i. Soot Blowers (02 Retractable + 14 Rotary)	:	16nos.

j. Start up vent valve : 01no.
k. Main steam stop valve : 01no.
l. Main steam bypass stop valve : 01no
m. Dumping grate cylinder : 06nos.
n. Feed water transfer pumps : 04nos.
o. Air compressors : 02nos.

The above drives are operated from operator console (DCS), and from local push button stations,
Boiler feed Pump, Turbo feed Pump, Feed Water Transfer Pump, Compressors are common for both the boilers.

2.1.2 The following drives are operated through local push buttons station only.

a. H.P dosing pumps : 04nos.
b. L.P dosing pumps : 02nos.
c. L.P Stirrer : 01no
d. H.P Stirrer : 02nos.

2.1.4 'Boiler Interlock O.K.' has been achieved through the following inputs :

a. Any ID Fan Running
b. Any FD Fan Running
c. Any SA Fan Running
d. Furnace Pressure O.K
e. Emergency PB's not operated.
f. Drum Level O.K

3.0 BOILER PANEL (BCP)

One no free vertical standing panel is considered for each boiler. This panel is to be installed/located in the control room near operator stations. BCP will have digital indicators for monitoring draft, level & temperature and also has annunciation window for each boiler. (Refer document: JB0632-50730100-POS-001)

4.0 Boiler Auxiliaries Trip/Shut down Procedure: (Refer doc. no. JB0632-50990400-IIK-001)

4.1 Boiler Feed Pumps (06nos):

6 nos. electrical driven boiler feed pumps are considered. MCC shall have following hardware inputs & outputs for remote operation from DCS

4.1.1 Digital Inputs potential free contact for DCS)

a. Run status
b. Trip status

4.1.2 Digital Outputs potential free contact from DCS

a. Remote mode selection
b. Start/Stop command

DCS will generate BFP "**start"** command after satisfying following conditions:

a. Deaerator level not low-low (from field switch 1LSLL-51& 1LIC-51in DCS)
b. Differential Pressure across suction strainer OK (from field DP switch)
c. START command from operator station

"Start" command will be withdrawn to stop the pump if any of the below condition get satisfied or acknowledged by DCS. (Ref JB0632-50990400-IIK-001 sh no 2, 3 & 4)

a. Deaearator level LOW-LOW (from field switch 1LSLL-51& 1LIC-51in DCS).
b. Differential pressure across suction strainer HIGH (from DP switch in field).
c. Temperature of motor (bearing of driving & non-driving end, winding) is high high.
d. Pump driving /non-driving end temperature is high high.
e. STOP command from operator station

4.2 **ID fans (02nos)**

VFD for each ID fan shall have following hardware inputs & outputs for remote operation from DCS

4.2.1 Digital Inputs potential free contact for DCS

a. Run status
b. Trip status

4.2.2 Digital Outputs potential free contact from DCS

a. Remote mode selection
b. Start/Stop command

4.2.3 Analog feedback (isolated 4-20mA signal to DCS)

a. Speed feedback

4.2.4 Analog reference signal (4-20mA signal from DCS)
a. Speed reference to vary the speed

DCS will generate ID "**start"** command after satisfying following conditions:

a. Inlet guide vane are at close condition (from ZSC-100A/B)
b. START command from operator station

"Start" command will be withdrawn to stop the fan if any of the below condition get satisfied or acknowledged by DCS. (Ref JB0632/33-50990400-IIK-001 sh no 5, 6)

a. Temperature of motor (bearing of driving & non-driving end, winding) is high-High
b. Fan driving /non-driving end temperature is high high.
c. STOP command from operator station

4.3 **FD fan (02no)**

VFD for each FD fan shall have following hardware inputs & outputs for remote operation from DCS

4.3.1 Digital Inputs potential free contact for DCS from VFD
a. Run status
b. Trip status

4.3.2 Digital Outputs potential free contact from DCS
a. Remote mode selection
b. Start/Stop command

4.3.3 Analog feedback (isolated 4-20mA signal to DCS)
a. Speed feedback

4.3.4 Analog reference signal (4-20mA signal from DCS)
a. Speed reference to vary the speed

DCS will generate FD "**start"** command after satisfying following conditions:

a. Inlet guide vane are at close condition (from ZSC-200A/B)
b. Any ID Fan RUN status
c. Drum level not low-low (from hydra step or field switch 1LSLL-01& 1LIC-01in DCS)
d. Furnace Pressure not high-high (from PIC-100 in DCS)
e. START command from operator station

"Start" command will be withdrawn to **stop** the fan if **any** of the below condition get satisfied or acknowledged by DCS. (Ref JB0632/33-50990400-IIK-001 sh. No-7)

a. Temperature of motor (bearing of driving & non-driving end, winding) is high high
b. Fan driving /non-driving end temperature is high.
c. Both ID fan stop status
d. Drum level low-low (from field switch LSLL-01& LIC-01in DCS)
e. Furnace Pressure high-high (from 1PIC-100 in DCS)
f. STOP command from operator station

4.4 **SA fan (02no)**

MCC shall have following hardware inputs & outputs for remote operation from DCS

4.4.1 Digital Inputs potential free contact for DCS)

a. Run status
b. Trip status

4.4.2 Digital Outputs potential free contact from DCS

a. Remote mode selection
b. Start/Stop command

DCS will generate SA "**start"** command after satisfying following conditions:

a. Inlet guide vane are at close condition (from ZSC-201A/B)

b. Any ID Fan RUN status
c. Any FD fan run status
d. START command from operator station

"Start" command will be withdrawn to **stop** the fan if **any** of the below condition get satisfied or acknowledged by DCS. (Ref JB0632/33-50990400-IIK-001)

a. Temperature of motor (bearing of driving & non-driving end, winding) is high-high
b. Fan driving /non-driving end temperature is high.
c. ID fan stop status
d. FD fan stop status
e. Drum level low-low (from field switch LSLL-01& LIC-01 in DCS)
f. Furnace Pressure high-high (from PIC-100 in DCS)
g. STOP command from operator station

4.5 **PA fan (02no)**

MCC shall have following hardware inputs & outputs for remote operation from DCS

4.4.1 Digital Inputs potential free contact for DCS)
a. Run status
b. Trip status

4.4.2 Digital Outputs potential free contact from DCS
a. Remote mode selection
b. Start/Stop command

DCS will generate PA "**start"** command after satisfying following conditions:
a. Inlet guide vane are at close condition
b. Any ID Fan RUN status
c. Any FD fan run status
d. Any SA fan run status
e. START command from operator station

"Start" command will be withdrawn to **stop** the fan if **any** of the below condition get satisfied or acknowledged by DCS. (Ref JB0632/33-50990400-IIK-001)

a. Temperature of motor (bearing of driving & non-driving end, winding) is high-high
b. Fan driving /non-driving end temperature is high.
c. ID fan stop status
d. FD fan stop status
e. SA fan stop status
f. Drum level low-low (from field switch LSLL-01 & LIC-01in DCS)
g. Furnace Pressure high-high (from PIC-100 in DCS)
h. STOP command from operator station

4.6 Drum Feeders (06nos)

VFD for each Drum Feeder shall have following hardware inputs & outputs for remote operation from DCS

4.6.1 Digital Inputs potential free contact for DCS

a. Run status
a. Trip status

4.6.2 Digital Outputs potential free contact from DCS
a. Remote mode selection
b. Start/Stop command

4.6.3 Analog feedback (isolated 4-20mA signal to DCS)
a. Speed feedback

4.6.4 Analog reference signal (4-20mA signal from DCS)
a. Speed reference to vary the speed

DCS will generate Drum feeder "**start"** command after satisfying following conditions:

a. Screw conveyor below the drum feeder RUN status
b. BOILER Interlock OK. (Refer point no 2.1.4)
c. START command from operator station

"Start" command will be withdrawn to **stop** the feeder if **any** of the below condition get satisfied or acknowledged by DCS. (Ref JB0632/33-50990400-IIK-001 sh no 10, 11, 12)

a. STOP command from operator station
b. Stop status of screw conveyor
c. Boiler interlocks not ok.

4.7 **Motorised actuators**
(Main steam stop valve, Main steam integral bypass valve, start up vent valve):

The motorised actuators are to be operated from DCS and from local push button station. The operator has to decide about the operation of actuators

4.7.1 Digital Inputs potential free contact for DCS
a. Full Open status
b. Full Close status
c. Trip status

4.7.2 Digital Outputs potential free contact for DCS
a. Remote selection
b. Open command
c. Close command

4.8 Retractable Soot Blower

4.8.1 Digital Inputs potential free contact for DCS
a. Home position
b. Forward Running status
c. Reverse Running status
d. Trip status

4.8.2 Digital Outputs potential free contact for DCS
a. Remote mode
b. Start/Stop command

4.9 Rotary Soot Blower

4.9.1 Digital Inputs potential free contact for DCS
a. Home position
b. Run status
c. Trip status

4.9.2 Digital Outputs potential free contact for DCS
a. Remote mode Selection
b. Start/Stop command

5.0 -pH & conductivity analysers are provided for feed water & superheated steam services and signal are transmitted to DCS for on-line monitoring.

6.0 SCADA Function

6.1.1 The following SCADA (for 1500 tags) functions are considered through DCS.

i. Set point ramp up/down function
ii. Manipulated variable ramp up/down function
iii. Diagnostics
iv. Alarm/ACK/Reset function
v. Trends and log reports
vi. Real/Historical trends display for minimum 60 days back up data.
vii. Data acquisition of all the digital, analog close and open loops.
viii. Monitoring of boiler parameters from operating console.
ix. Data overview displays.
x. Graphical mimic with dynamic animation of boiler P & I diagram
xi. Data storage and retrieval.
xii. On demand shift/daily/weekly report generation.
xiii. Extensive alarm management.

6.1.2 Printouts of trends, reporting and mimics are available through colour inkjet printer and DOT matrix printer.

7.0 One no. Uninterrupted Power Supply (UPS of 10KVA is supplied for power up of DCS system, field analyser like Oxygen analyser, pH analyser, conductivity analyser, drum level gauges, remote level indicators.

8.0 Inputs required from Client

- 230 V AC incoming power supply for UPS
- Air Conditioner for Control Room
- Necessary hardware like furniture etc for Engineering & Operator Stations

Note: Basic control philosophy will remain same for both the boilers. Prefix ‘1’ is to be used for 1st boiler & ‘2’ for 2nd boiler instrument tags.